NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME

SUBJECT CLASS

REGISTRATION NUMBER

CHEMISTRY
8873/02

Paper 2 Structured Questions

Tuesday 24 August 2021
2 hours

Candidates answer on the Question Paper.
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, index number, form class, tutorial class and subject tutor's name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** the questions.

Section B
Answer **one** question.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Question no.	**Marks**
Section A	
B7	
B8	
TOTAL	**/80**

This document consists of xx printed pages and xx blank pages.

Section A

Answer **all** the questions in this section in the spaces provided.

1 (a) Sulfur reacts with an element **A** to form a compound with empirical formula S**A**$_2$. The percentage by mass of **A** in S**A**$_2$ is 83.2%.

(i) Assuming the relative atomic mass of **A** to be **y**. Find the number of moles of **A** and S respectively in terms of **y**.

Element	**A**	**S**
No. of moles/ mol	$\frac{83.2}{y}$	$\frac{100-83.2}{32.1}$ or 0.523

[1]

(ii) Hence, find the value of **y**.

Mole ratio of A : S = 2 : 1 = $\frac{83.2}{y}$: $\frac{100-83.2}{32.1}$

No. of moles of A atoms = 2 × no. of moles of S atoms

$\frac{83.2}{y} = 2 \times \frac{100-83.2}{32.1}$

***y* = 79.5**

[1]

(iii) Element **A** is from Group 17. Hence, identify Element **A** using your answer in **a(ii)**.

Bromine

[1]

Sulfur has 21 unstable isotopes. Among these isotopes, the one with the longest half-life of 85 days is ^{35}S isotope.

(b) (i) Suggest the time taken for ^{35}S to decrease to 6.25% of its initial amount.

100% → 50% → 25% → 12.5% → 6.25%

Time taken = 85 x 4 = **340 days**

[2]

(ii) When an atom of ^{40}Ar collides with a high-speed neutron, ^{35}S and another product is produced. State the identity of this product, including its mass and proton number.

$$^{40}_{18}Ar + {}^{1}_{0}n \longrightarrow {}^{35}_{16}S + \_\_\_\_\_\_$$

$^{6}_{2}He$

(conservation of protons and mass number)

	Left side	Right side
Mass number	40 + 1 = 41	35 + x = 41 x = 6
No. of protons	18 + 0 =18	16 + y = 18 y = 2

Hence the product's mass number is 6 and number of protons is 2.
From the Periodic Table, the element that has 2 protons is He.

[1]

(c) Disulfur dichloride, S_2Cl_2, is an important precursor of the extremely toxic chemical warfare agent sulfur mustard. It was widely used during the First World War and the Iran–Iraq conflict.

S_2Cl_2 can be synthesized at 200 °C as shown in the reaction below.

$$CS_2\,(g) + 3\,Cl_2\,(g) \longrightarrow CCl_4\,(g) + S_2Cl_2\,(g)$$

(i) Given the structural formula of disulfur dichloride, S_2Cl_2 is $Cl—S—S—Cl$.

Draw the 'dot-and-cross' diagram of S_2Cl_2 and state the $Cl—S—S$ bond angle.

$Cl—S—S$ bond angle = 104.5°

[2]

(ii) In terms of structure and bonding, predict the difference in boiling point between CCl_4 and S_2Cl_2.

Compound	M_r	Boiling Point/ °C
CCl_4	154.0	77
S_2Cl_2	135.2	138

Both CCl_4 and S_2Cl_2 exists as **simple molecular structure**

Less energy is required to overcome the **weaker instantaneous dipole-induced dipole between CCl_4 molecules** than **permanent dipole-permanent dipole between S_2Cl_2 molecules.**

[2]

[Total: 10]

2 (a) In the Haber Process, nitrogen reacts with hydrogen to form ammonia in the presence of iron catalyst. This reaction is reversible and exothermic.

Write a balanced equation for the Haber Process

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

[1]

(b) A 20 cm^3 vessel containing 0.833 mol of N_2 was connected with another 80 cm^3 vessel containing 3.33 mol of H_2. The reaction mixture was heated at a constant temperature of 500 °C. At equilibrium, 0.298 mol of NH_3 was produced.

(i) Write the K_c expression for the Haber Process. State its units.

$K_c = \frac{[NH3]^2}{[N2][H2]^3}$ mol^{-2}dm^6

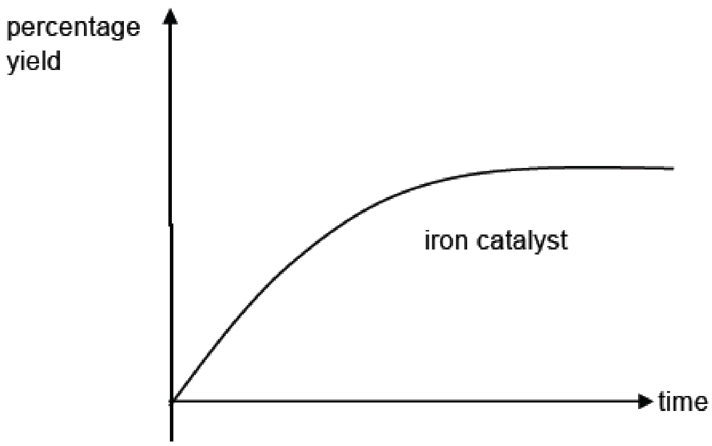
[2]

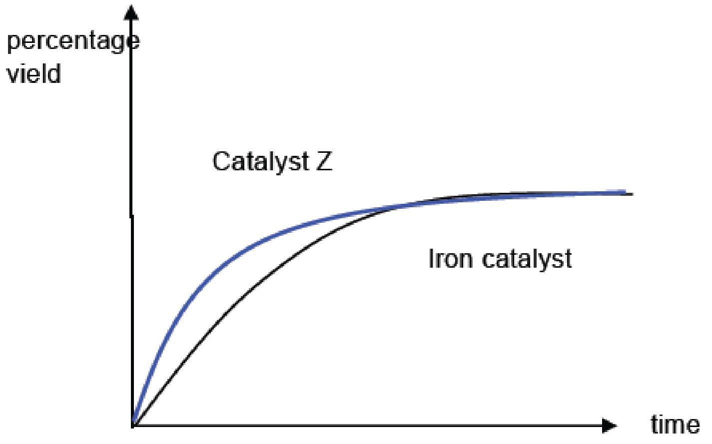
(ii) Use the information given, calculate the value of K_c.

	N_2	+	$3H_2$	$\rightleftharpoons$	$2NH_3$
Initial amt	0.833		3.33		0
Change	$-\frac{1}{2}\times0.298$ = –0.149		$-\frac{3}{2}\times0.298$ = –0.447		+0.298
Equilibrium amt	0.684		2.883		0.298
Equilibrium conc	$\frac{0.684}{0.1} = 6.84$		$\frac{2.883}{0.1}$ = 28.83		$\frac{0.298}{0.1} = 2.98$

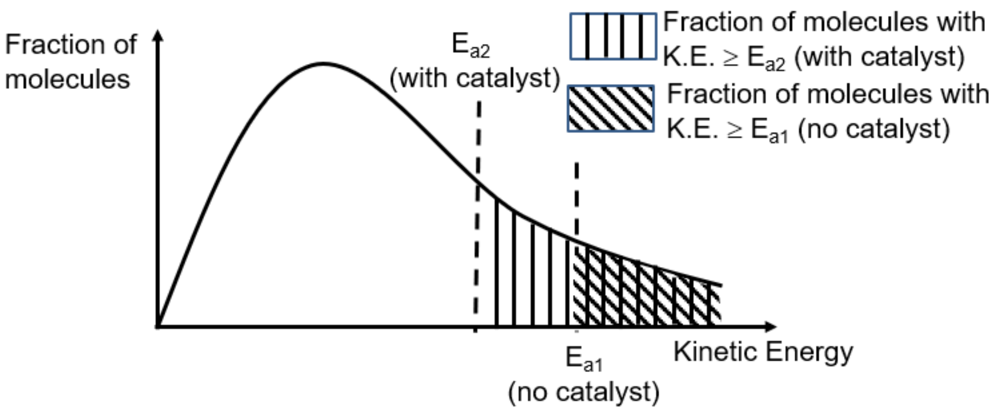
$K_c = \frac{(2.98)^2}{(6.84)(28.83)^3} = 5.42 \times 10^{-5}$

[2]

		(iii)	By using La Chatelier's Principle, explain why the Haber Process needs to be conduced at an optimal temperature of 500 °C.
			A **low temperature** will favour the **exothermic** reaction to produce some heat. The equilibrium position will shift to the right to produce more ammonia. However, at lower temperatures, **rate of reaction is slower**. [1]
	(c)	State and explain the effect, if any, on how a change to the following will affect the K_c value.	
			I: Increase in temperature
			Increase in temperature will favour **endothermic reaction/ backward rxn/ position of equilibrium shift left**. K_c **will decrease**.
			II: Increase in concentration of N_2
			Increase in $[N_2]$ will **not affect** K_c as there is no change in temperature.
			[3]
	(d)	**(i)**	The graph below shows how the percentage yield of ammonia varies over time by using iron as the catalyst.  A new catalyst **Z** was introduced and results showed that it can increase the rate of reaction better than that of iron. Sketch on the graph for the new catalyst **Z** on the same axes shown above. [2]



(d) **(ii)** Explain how iron catalyst can increase the rate of formation of ammonia.



The catalyst provides an **alternative reaction pathway with lower activation energy** (E_{a2}).
The **fraction of molecules with K.E. ≥ E_a increases**. The **frequency of effective collisions increases** hence rate of reaction increases.

[3]

[Total: 14]

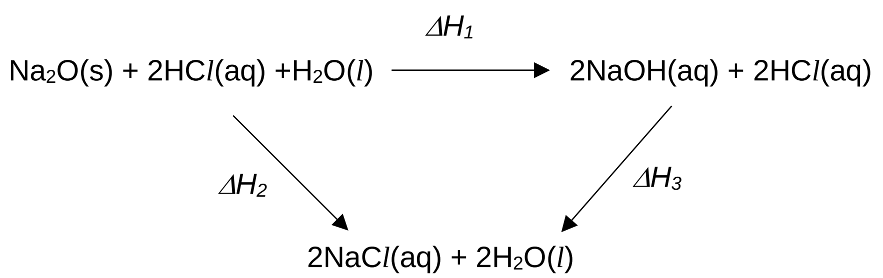
3 **(a)** Methanoic acid, HCOOH, being a weak acid, is the simplest carboxylic acid and is an important intermediate in chemical synthesis.

The energy content of methanoic acid can be determined by means of calorimetric experiments. These experiments are usually carried out using polystyrene cup in a normal school laboratory. The standard enthalpy change of neutralisation can also be determined.

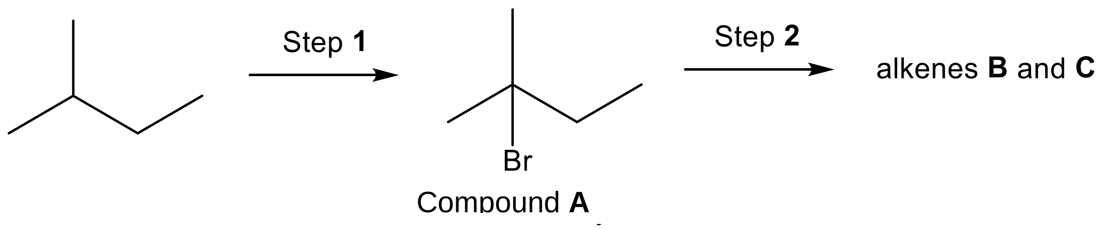
(i) Define what is meant by the *standard enthalpy change of neutralisation*.

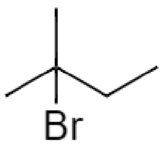
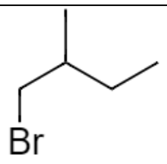
Energy evolved when 1 mole of water is formed when an acid is completely neutralised by alkali under standard conditions.

[1]

		(ii)	Write a balanced equation for the neutralisation of methanoic acid with potassium hydroxide. [1]
			$HCOOH + KOH \rightarrow HCOO^{-}K^{+} + H_2O$
		(iii)	How would you expect the enthalpy change of neutralisation in **a(ii)** to compare with the enthalpy change of neutralisation of nitric acid with potassium hydroxide? Explain your answer. [1]
			The enthalpy change of neutralisation in **a(ii)** will be **less exothermic**. Some of the heat evolved is **absorbed** to **fully dissociate** the methanoic acid. Hence less heat is evolved.
		(iv)	Suggest a suitable indicator for the titration between methanoic acid and potassium hydroxide. [1]
			Phenolphthalein / thymol blue
	(b)	Study the energy cycle and answer the questions that follow.  	
		(i)	When 7.0 g of Na_2O(s) is dissolved in 200 cm^3 of 1.5 mol dm^{-3} HCl(aq), the temperature of the solution increased by 15 °C. Calculate ΔH_2
			$Na_2O(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(l)$ Amount of Na_2O = $\frac{7.0}{2(23.0)+16.0}$ = 0.1129 mol Amount of HCl = $\frac{200}{1000} \times 1.5$ = 0.3 mol Limiting reagent is Na_2O Hence amount of water formed = 0.1129 mol Heat evolved = (200)(4.18)(15) = 12540J $\Delta H = -\frac{12540}{0.1129} = -111$ kJ mol^{-1} [3]

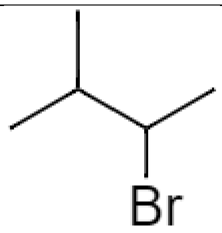
		(ii)	By making use of the energy cycle and your answer to **b(i)**, calculate ΔH_1. Given ethalpy change of neutralisation between NaOH(aq) and HC*l*(aq) is –57.0 kJ mol^{-1}.
			ΔH_1 = –111 – 2(–57.0) = +3 kJ mol^{-1} [2]
			[Total: 9]

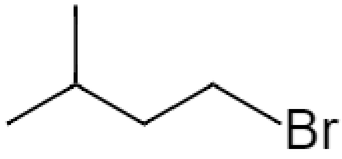
4	The following reaction scheme involves a series of reactions involving different organic compounds.. 	
	(a)	State the name of compound **A**.
		2-bromo-2methylbutane [1]
	(b)	State the reagents and conditions required for Steps **1** and **2**. Step **1**: (limited) **Br_2, UV** light Step **2**: **Ethanolic NaOH, heat** [2]
	(c)	In addition to compound **A** that is formed at the end of Step **1**, compound **D**, which is an isomer of compound **A**, is also produced. Fill in the expected ratio of isomer **D**.

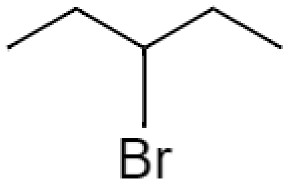
Structure	 Compound **A**	 Compound **D**
Ratio	1	*6*

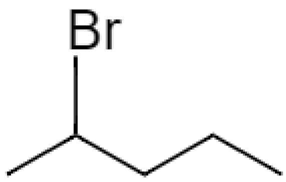
[1]

(d) By considering the molecular formula, draw the skeletal formula of two more isomers that are constitutional isomers of compound **A** and **D**.



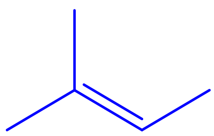






[2]

(e) Alkene **B** undergoes an addition reaction with Br_2 in CCl_4 to form 2, 3-dibromo-2-methylbutane. Identify the structure of alkene **B**.



[1]

	(f)	Suggest a simple chemical test to distinguish between compound **A** and compound **B**.
		Test: Add **Br_2 (aq)** to both compounds. Observation: Compound **B** will **decolourise orange Br_2**, while compound **A** will **remain orange**. OR Test: Add **Br_2 in CCl_4** Observation: Compound **B** will **decolourise orange-red Br_2**, while compound **A** will **remain orange-red**. OR Test: Add **NaOH (aq)**, and **heat** both compounds. Acidify with **HNO_3 (aq).** Then add **$AgNO_3$ (aq).** Observation: Compund **A** will give **cream ppt**, while compound **B** does **not give any ppt**. [2]
		[Total: 9]

5 The water of crystallisation in hydrated barium bromide, $BaBr_2.xH_2O$ is lost when heated.

$$BaBr_2.xH_2O\ (s) \longrightarrow BaBr_2\ (s) + xH_2O\ (g)$$

The varying mass samples of hydrated barium bromide are heated in the experiment. To determine the number of molecules of H_2O in hydrated barium bromide, a graph of the mass of hydrated barium bromide against the mass of anhydrous barium bromide left after heating is plotted.

A student weighed 0.60 g of hydrated barium bromide and transferred it into a crucible. The crucible and the contents were heated until a constant mass has been reached. This mass was then recorded.

The student repeated the experiment using different masses of hydrated barium bromide. For each experiment the student recorded the original mass of the hydrated barium bromide and the mass of anhydrous barium bromide left after heating.

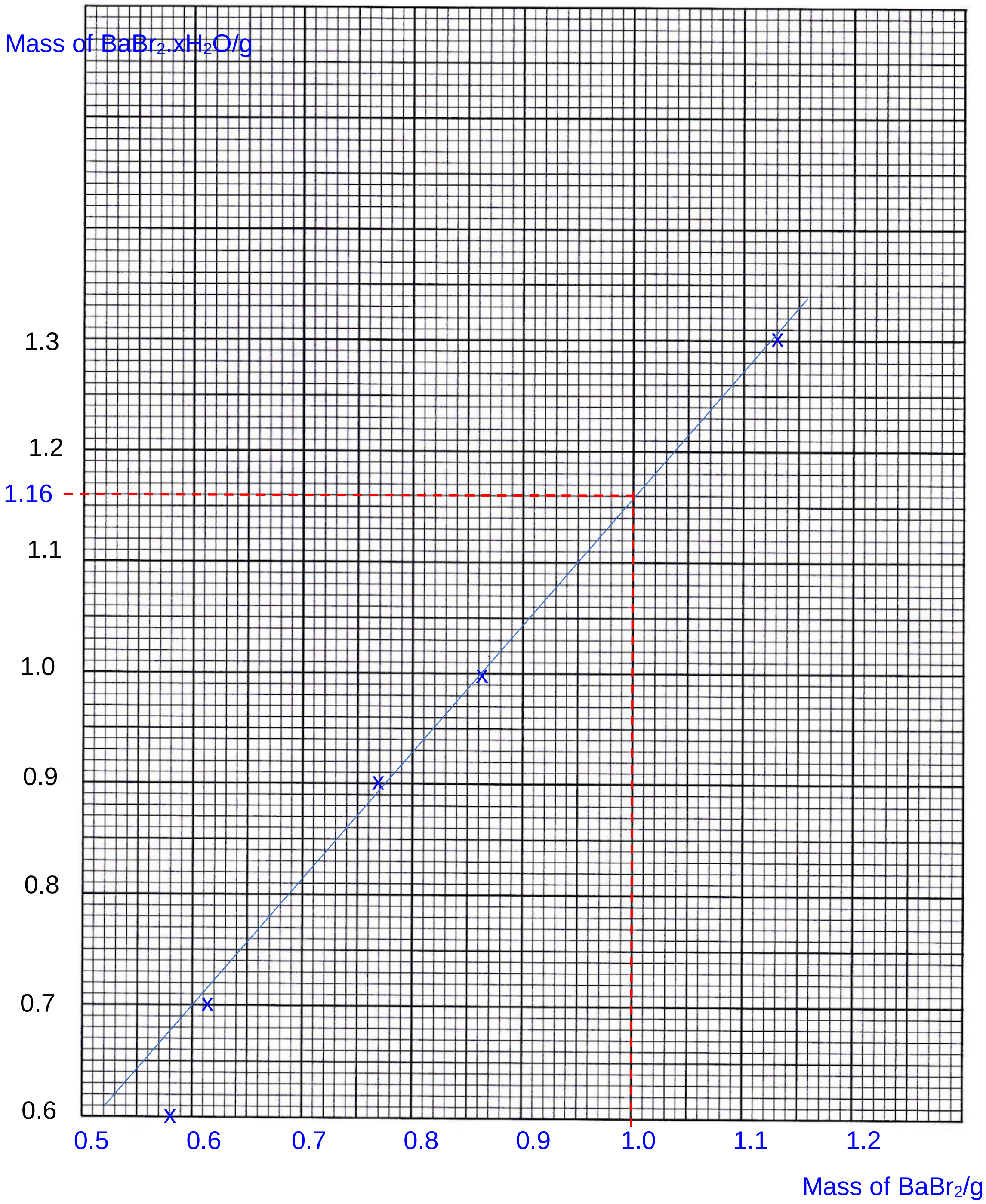
The results are shown below:

Results

Experiment	Mass of $BaBr_2.xH_2O$ / g	Mass of $BaBr_2$ / g
1	0.60	0.58
2	0.70	0.61
3	0.90	0.77
4	1.00	0.86
5	1.30	1.13

(a) Plot on the grid below, a graph of the mass of hydrated barium bromide on the y-axis, against the mass of the anhydrous barium bromide on the x-axis.

Draw the most appropriate line.



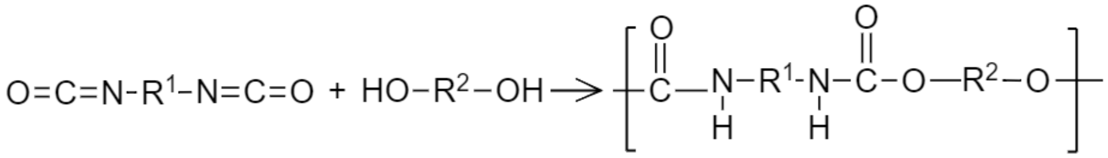
Use the graph to determine the mass of hydrated barium bromide which forms 1.00g of anhydrous barium bromide.

Mass = ………1.16g……………..

[4]

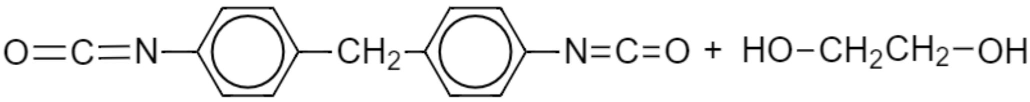
	(b)	Calculate the number of moles of $BaBr_2$ present in 1.00 g of anhydrous barium bromide.
		No. of moles of $BaBr_2$ = $\frac{1.00}{137.3+2(79.9)}$ = 3.37×10^{-3} mol [1]
	(c)	Using your answer from **(a)** and **(b)**, calculate the M_r of hydrated barium bromide.
		No. of moles of $BaBr_2.xH_2O$ = No. of moles of $BaBr_2$ M_r of $BaBr_2.xH_2O$ = $\frac{1.16}{3.37 \times 10^{-3}}$ = 344.6 [1]
	(d)	Hence calculate the value of x in $BaBr_2.xH_2O$. Give your answer to the nearest whole number.
		344.6 = 137.3 + 2(79.9) + 18x x = 2.64 ≈ 3 [1]
	(e)	A databook value for the M_r of hydrated barium bromide is 333.1. Calculate the difference between the M_r value obtained from the student's data and the databook value. Express this difference as a percentage of the databook value.
		Percentage difference = $\frac{(344.6-333.1)}{333.1} \times 100$ = 3.45% [1]
		[Total: 8]

6 **(a)** Polyurethanes are polymers made by the reaction of a diisocyanate with a diol as shown. R^1 and R^2 are hydrocarbons groups.

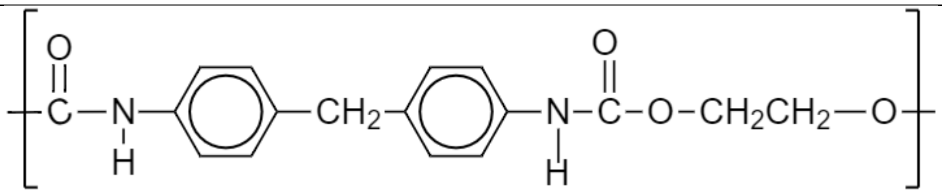


a diisocyanate   a diol   a polyurethane

Lycra, an example of polyurethane, is formed from the following compounds.

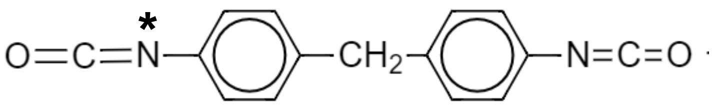


(i) Draw the repeat unit of Lycra.



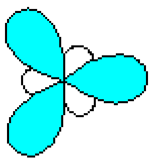
[2]

(ii) By considering the number of electron pairs, state the hybridisation on the N atom marked with *. Draw the shape of the hybridised orbital in the space below.



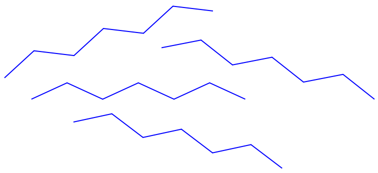
Hybridisation of N: ………………. sp^2

Drawing for the shape of hybridised orbital:

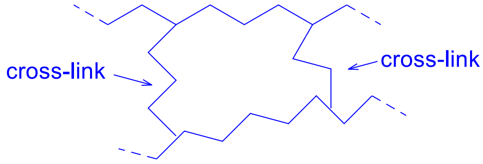


[2]

(b) With the aid of a simple well-labelled diagram, explain how thermoplastics differ from thermosets in their bonding between polymer chains.



Thermoplastic



Thermoset

Thermoplastic polymer has **little or no cross links between chains** and have **weak instantaneous dipole – induced dipole interactions** between its chains while thermosetting polymers are highly **cross linked by strong covalent bonds** formed between chains.

[3]

(c) Give one example of each of the following types of polymer.

type of polymer	**example**
wrinkle-free fabric	polyester
water soluble	PVA

[2]

[Total: 9]

Answer **one** question from this section in the spaces provided.

7 Selenium and bromine are found in Period 4 of the Periodic Table.

(a) (i) Write an equation to represent the third ionization energy of Br.

Br^{2+} (g) → Br^{3+} (g) + e

[1]

(ii) Write down the full electronic configuration of Br^{2+} and Se^{2+}.

Br^{2+}:$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3$

Se^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2$

[2]

(iii) State whether the 3rd ionization energy of bromine is higher or lower than that of selenium. Explain your answer.

Br^{2+} has **higher nuclear charge** than Se^{2+}. Both have **similar shielding effect** by inner shell electrons. Hence, the **most loosely held electron** in Br^{2+} experience a **stronger nuclear attraction** and **more energy** is required to remove this electron. Hence 3rd ionization energy of bromine is **higher**.

[2]

(iv) Suggest with a reason how the first ionisation energy of ^{79}Br is compared to ^{81}Br.

First ionisation energy of ^{79}Br is the **same** as that of ^{81}Br because they have the **same number of protons and electrons**.

(b) The oxide of **M** dissolves partially in water to give an alkaline solution, while its chloride readily dissolves in water to give a slightly acidic solution.

1. Identify element **M**.

Element **M** is ……………………… Mg

2. State the pH of the resultant solution when the oxide and chloride of **M** are added to water separately. Write appropriate equations to support your answer.

	equations for reaction with water	pH of resultant solution
oxide of **M**	$MgO(s) + H_2O(l) \rightleftharpoons Mg(OH)_2(aq)$	9

		chloride of **M**	Hydration $MgCl_2(s) + 6H_2O(l) \rightarrow [Mg(H_2O)_6]^{2+}(aq) + Cl^-(aq)$ Slight Hydrolysis $[Mg(H_2O)_6]^{2+}(aq) \rightleftharpoons [Mg(H_2O)_5(OH)]^+(aq) + H^+(aq)$	6.5	
					[4]

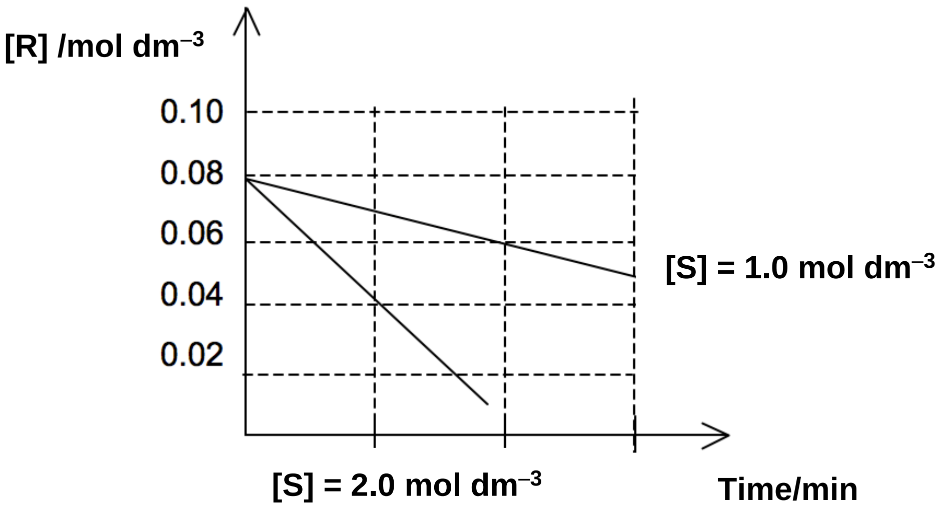
(c)	**(i)**	Calculate the pH of a 0.100 mol dm^{-3} solution of H_2SO_4.
		$[H^+] = 0.100 \times 2 = 0.200$ mol dm^{-3} pH = $-lg[H^+] = -lg(0.200) =$ **0.699 or 0.7** [1]
	(ii)	Chromic acid, H_2CrO_4, like sulfuric acid, is a dibasic acid. However, unlike sulfuric acid, chromic acid does not undergo full dissociation in water. $H_2CrO_4 \rightleftharpoons HCrO_4^- + H^+$ $HCrO_4^- \rightleftharpoons CrO_4^{2-} + H^+$ Solution **A**, formed by adding equal amounts of $NaHCrO_4$ and Na_2CrO_4, is a *weak acid buffer*. Explain how this buffer can help to maintain a fairly constant pH.
		When a small amount of acid is added, $\mathbf{CrO_4^{2-} + H^+ \rightarrow HCrO_4^-}$ A **large reservoir of CrO_4^{2-}** removes the added H^+ to maintain a **fairly constant pH**. When a small amount of base is added, $\mathbf{HCrO_4^- + OH^- \rightarrow CrO_4^{2-} + H_2O}$ A **large reservoir of $HCrO_4^-$** removes the added OH^- to maintain a **fairly constant pH**. [3]

(d) Substances ***R*** and ***S*** react according to the following equation:

$$R\,(aq) + 2S\,(aq) \longrightarrow 2U\,(aq) + V\,(aq)$$

To find the rate equation for the above reaction, experiments were performed and the results are shown below.

(i) Use the graph below to determine the order of reaction with respect to **R** and **S**. Justify your answer in each case. Hence, write the rate equation.



The graph shows a **straight line** with constant gradient. Rate of reaction is constant.
Order of reaction wrt R is 0. (When [R] changes, rate remains constant.)

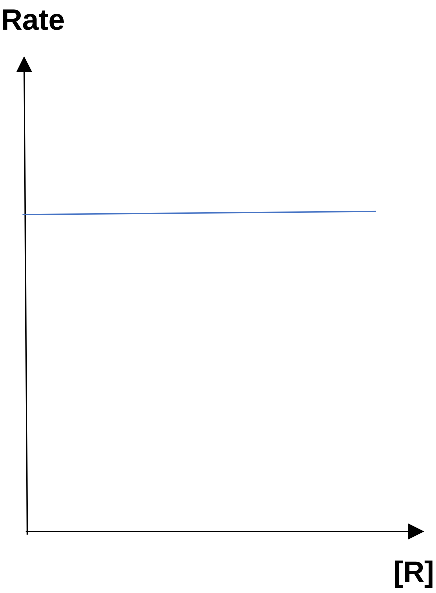
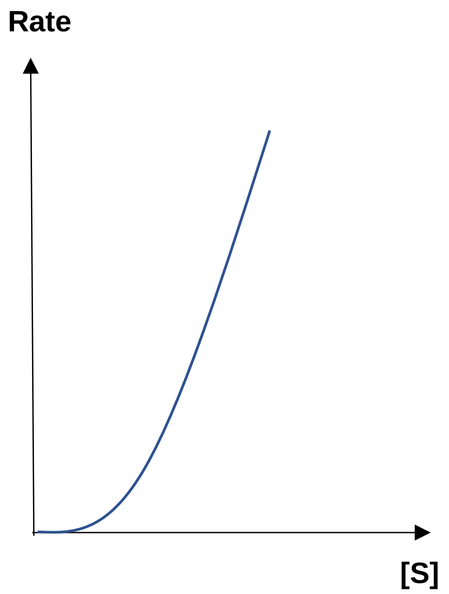
When [S] is 1.0 moldm^{-3}
Initial rate = $\frac{0.08-0.06}{2}$ = 0.01 mol dm^{-3} min^{-1}

When [S] is 2.0 moldm^{-3}
Initial rate = $\frac{0.08-0.04}{1}$ = 0.04 mol dm^{-3} min^{-1}

When [S] doubles, rate quadruples
Order of reaction wrt S is 2.

Rate equation:.Rate = k[S]^2

[3]

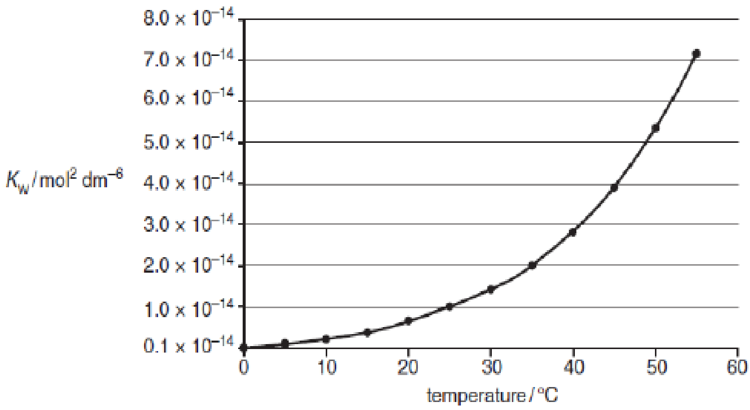
		(ii)	Sketch the rate vs. concentration graph of **R** and **S** separately on the graphs below.
			  [2]
		(iii)	Calculate the rate constant of the reaction, when the concentration of S is 2.0 mol dm^{-3}.
			Since [S] is 2.0 mol dm^{-3} Initial rate = 0.04 mol dm^{-3} min^{-1} Rate = $k[S]^2$ k = 0.04 / $(2.0)^2$ = 0.0100 mol^{-1} dm^3 min^{-1} [1]
			[Total: 20]

8 **(a)** The dissociation of water is a reversible reaction.

$$H_2O \rightleftharpoons H^+ (aq) + OH^- (aq)$$

The ionic product of water, K_w, measures the extent of dissociation of water. K_w varies with temperature.

The graph below shows how the K_w varies between 0 – 60 °C.



(i) Write an expression for K_w.

$K_w = [H^+][OH^-]$

[1]

(ii) Calculate the concentration of hydroxide ions in an aqueous solution of hydrochloric acid at pH of 3.5 at 35 °C.

$[H^+] = 10^{-3.5} = 3.16 \times 10^{-4}$ mol dm^{-3}

At 35°C

$K_w = [H^+][OH^-]$

$2.0 \times 10^{-14} = (3.16 \times 10^{-4})[OH^-]$

$[OH^-] = 6.33 \times 10^{-11}$ mol dm^{-3}

[2]

	(b)	A key reaction in the formation of acid rain and in the industrial production of nitric acid is the reaction between nitrogen monoxide and oxygen. $$O_2(g) + 2NO(g) \rightarrow 2NO_2(g)$$ An investigation into the kinetics of the reaction between $O_2(g)$ and NO(g) is conducted at 25 ºC. The result is as shown on **Figure A**.

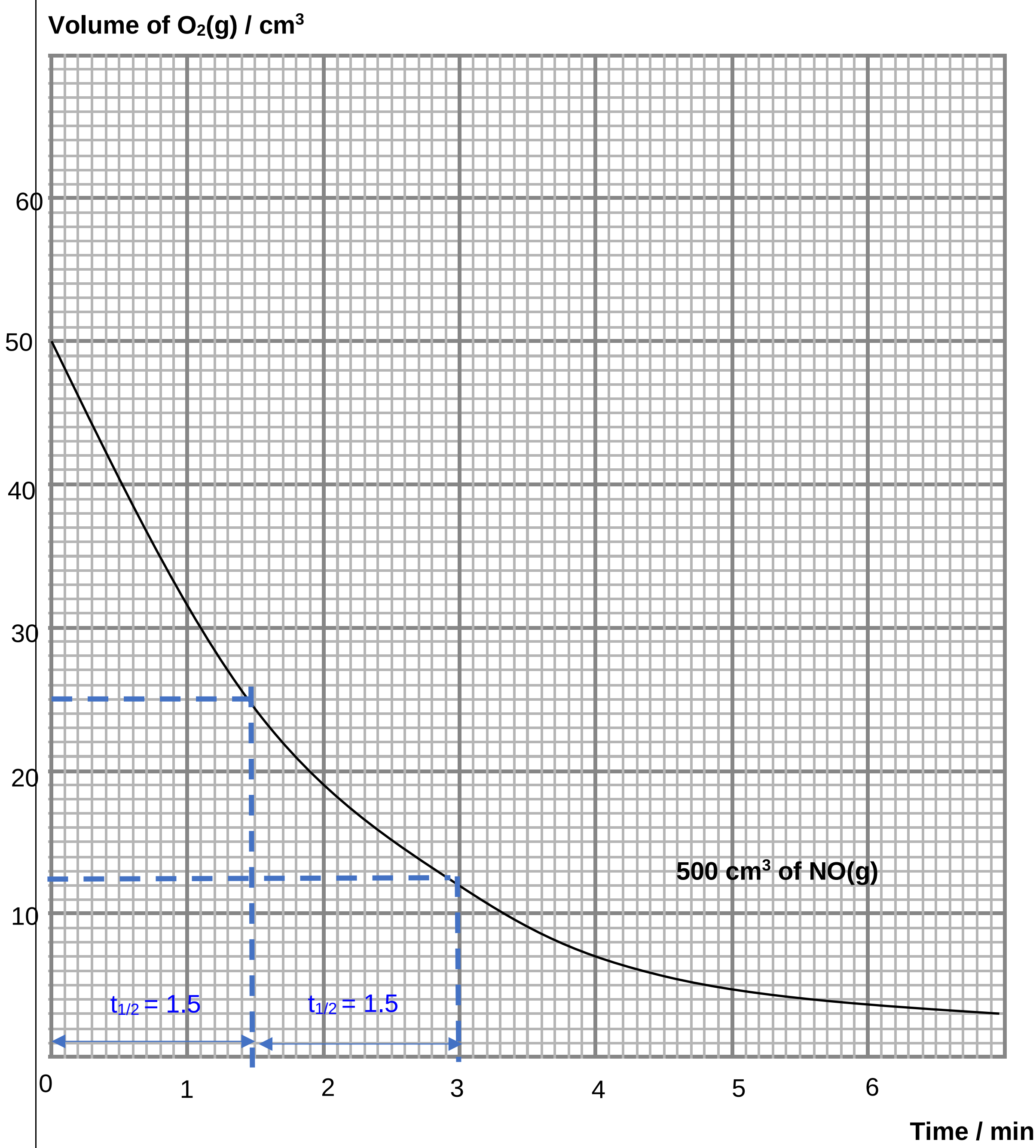


Figure A

(i) Using the graph in **A**, deduce the order of the reaction with respect to O_2(g).

The half-life is constant at 1.5min.
Order of reaction with respect to O_2 is 1

[2]

(ii) A series of experiments were performed to investigate the order of reaction with respect to NO. The data collected is shown in **Table B**.

Expt	Initial $[O_2]$/ mol dm^{-3}	Initial [NO]/ mol dm^{-3}	Temperature/ K	Initial rate/ mol $dm^{-3}s^{-1}$
1	0.01	0.013	298	0.0032
2	0.01	0.013	318	0.0135
3	0.01	0.026	298	0.0032

Table B

Determine the order of reaction with respect to NO and write the rate equation for the reaction between NO(g) and O_2(g).

Order of reaction with respect to NO:…………….. zero

Rate equation:

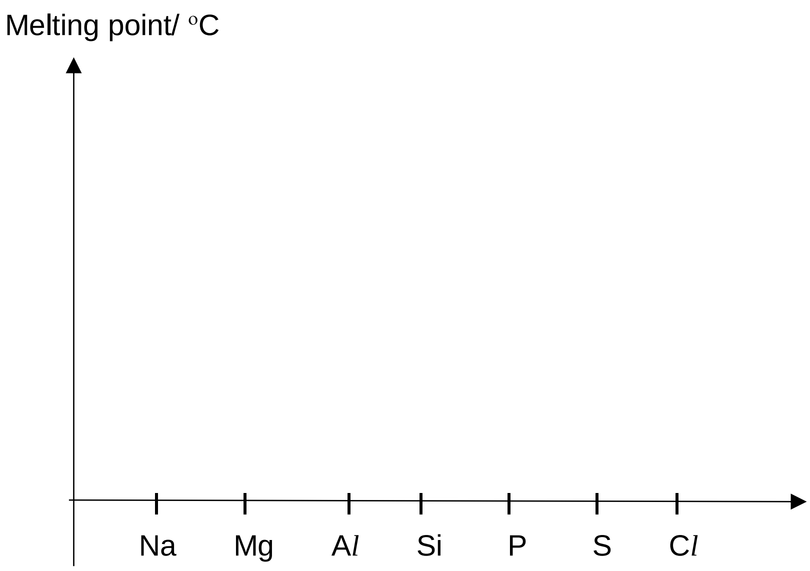
……………………………………………………………………………

Rate= $k[O_2]$

[2]

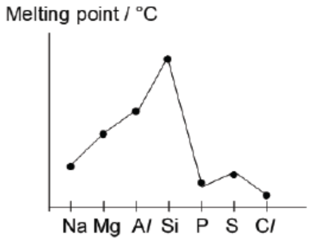
(c) Elements of Period 3 show trends in their reactions.

(i) Sketch the melting point trend for Period 3 elements from sodium to chlorine.



[1]

(i)



(ii) By considering the structure and bonding, explain for the observed melting point of silicon.

[1]

Silicon has **giant covalent structure**. **A lot of energy** is required to overcome the **strong covalent bonds between the Si atoms**.

(iii) The table below shows the successive ionisation energy values for phosphorus.

	1st	2nd	3rd	4th	5th	6th	7th	8th
IE/ $kJ\ mol^{-1}$	1060	1900	2920	4960	6280	21200	25200	30500

Explain how this data shows that phosphorus is a member of Group 15 of the Periodic Table.

Sharp increase between 5th to 6th IE. **6th electron is removed from inner electronic shell. There are 5 valence electrons.** Therefore phosphorus is a Group 15 element.

[1]

(iv) Silicon reacts with calcium to form Ca_2Si. Ca_2Si is thought to contain the Si^{4-} ion. Write out the electronic configuration of Si^{4-}.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

[1]

(v) Compare the difference in size between Si^{4-} and Ca^{2+}.

Both ions are **isoelectronic**. **Nuclear charge Ca^{2+} is larger**. The **nuclear attraction on the outermost electrons** in Ca^{2+} is **stronger**. Hence size of Ca^{2+} is **smaller**.

[2]

(vi) The elements sodium, aluminium and sulfur react with oxygen to form oxides. Write equations, if any, for the reactions of each of these oxides with water. State the pH of the resultant solution formed.

$Na_2O + H_2O \rightarrow 2NaOH$ pH=13 or 14
Al_2O_3 **does not dissolve in water** pH = 7
$SO_3 + H_2O \rightarrow H_2SO_4$ pH =1 – 2

[4]

(d) There are three bottles labelled **A**, **B** and **C** in the laboratory. Each bottle contains one of the following reagents: aqueous Cl_2, KI solution and KBr solution.

The following tests were carried out and the results were summarised in the table below.

Experiment	Procedure	Observations
1	mixing reagent in bottle **A** with reagent in bottle **B**	mixture remains colourless
2	mixing reagent in bottle **A** with reagent in bottle **C**	mixture turns brown
3	mixing reagent in bottle **B** with reagent in bottle **C**	mixture turns brown

(i) Which bottle contains aqueous Cl_2? With the aid of a balanced equation, explain your answer.

[2]

Bottle **C**

$Cl_2 + 2X^- \longrightarrow 2Cl^- + X_2$ where X = Br or I

Down the group, the halogens have **lower tendency to be reduced**.
Stronger oxidising agent higher in the Group oxidises (and hence displaces) the **halide ions in aqueous solution further down the** Group

(ii) If hexane is also provided, how would you use it to identify the contents of the other two bottles? Include the observations in your answer.

[1]

Since bottle **A** and **B** is either KBr or KI, add hexane to the two brown mixtures obtained, separately.

If the organic layer is **purple, bottle contains KI.**
If the organic layer is **orange-red, bottle contains KBr.**

[Total: 20]